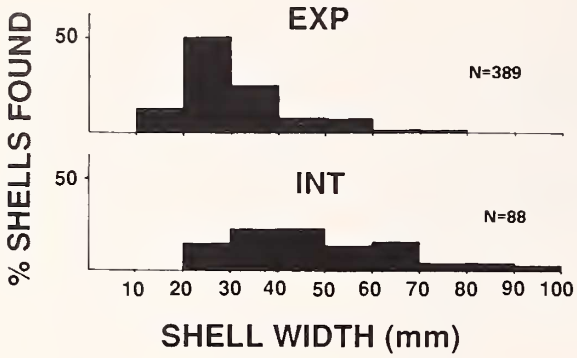

Figure 6

Size frequencies for dead *Cittarium* shells found in EXP and INT habitat types.

to increased predation (Underwood & Denley, 1984; Moran, 1985), may be less at EXSS sites.

Cittarium size-frequency distributions differed greatly with differences in habitat wave-exposure and topography. A preponderance of small snails was found at EXP sites, where growth rates were low and mortality was high. At SH and INT sites, where growth rates were high and mortality was low, large snails were relatively more abundant.

Large-scale movement of large snails into SH or INT habitat is, in most cases, unlikely because of intervening sandy areas. Because losses due to fishing could also be considered negligible, differences between habitats in terms of survival and growth appear to be the main contributors to the gross differences seen in population structure. Negatively skewed size-frequency distributions, as found in SH habitat, have been described for other reef invertebrates (Yamaguchi, 1977). Such distributions may result from size-differential recovery efficiency (Appeldoorn & Ballantine, 1983; Ault & DeMartini, 1987) or temporal variability in recruitment (Frank, 1969; Underwood, 1975) but may also be attributed to animals surviving to near their maximum size. Annual growth increments monotonically decrease at sizes approaching L_∞, and population modes, consequently, tend to merge (Sainsbury, 1982). The latter may explain the negatively skewed size-frequency distributions in this study for two reasons. The first is that all such distributions were from the habitat where survival and growth rates were highest (SH), and where, therefore, the accumulation of old animals was likeliest. The second is that the implied merging of age-class modes occurred near L_∞ and not in the intermediate size classes. Large population modes at intermediate size classes would have suggested that other factors, such as temporal variability in recruitment or survival, were also important factors shaping size structure.

Table 6

Von Bertalanffy growth parameter estimates for *Cittarium* with 95% confidence intervals. Parameter estimates are from snails that were at large August 1984–January 1985. *K* is expressed as an annual rate.

Habitat type	Site number	*n*	*K*	L_∞ (mm)
EXP	All sites	9	0.056 ± 0.054	167.94 ± 84.13
SH	10	17	0.291 ± 0.036	84.00 ± 5.95
	13	26	0.659 ± 0.034	81.12 ± 2.18
	14	14	0.369 ± 0.022	88.84 ± 2.83

Table 7

Size-specific average gonad indices (G.I.) and sample sizes for *Cittarium* collected in August 1984 in three habitat types.

	Habitat type						
	EXP		INT		SH		
Size (mm)	G.I.	*n*	G.I.	*n*	G.I.	*n*	*P**
11–20	0.10	4	—	—	—	—	—
21–30	0.11	40	0.30	2	0.16	8	0.468
31–40	0.21	36	0.43	3	0.23	14	0.042
41–50	0.08	31	0.42	8	0.26	11	0.000
51–60	0.10	5	0.29	7	0.33	6	0.056
61–70	0.33	3	0.40	7	0.44	17	0.270
71–80	—	—	0.52	1	0.45	11	—
81–90	—	—	—	—	0.40	7	—

* *P*-values are for statistical comparisons between habitat types. ANOVA *F*-tests. Dashes indicate data not available or test not made.

Randall (1964) noted that *Cittarium* is generally rare on sheltered coasts. Compared to more exposed habitats, lower population densities in SH habitat could either be from lower levels of settlement or lower levels of subsequent survival. In this study it was found that rates of survival and growth for snails greater than 20 mm were comparatively high in SH habitat. Thus, low densities in SH habitat appear to be caused by factors affecting settlement or the early postlarval stages of the snail.

Factors that may affect settlement include the supply of larvae and settlement preferences. Because SH sites had dramatically lower *Cittarium* population densities in spite of their often close proximity to high snail-density EXP and INT habitats, the low population densities in SH habitat were probably not due to reduced supplies of larvae. Reduced survival of juveniles because of desiccation during low tide may contribute to low densities in SH habitat. In contrast to large snails, those smaller than 10 mm did not appear to migrate to lower intertidal zones during low tide but remained in the upper intertidal zones (Debrot, 1990). In EXP and EXSS habitats such snails would be wet periodically, but in SH habitat they could experience periods of up to 12 hr without immersion.

Although the cause for lower population densities of young snails in SH habitat remains unknown, the low densities of conspecifics and predators in such habitat seem to translate into higher growth and survival rates for snails of the size range studied.

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THE VELIGER

The Diet and Feeding Selectivity of the Chiton *Stenoplax heathiana* Berry, 1946 (Mollusca: Polyplacophora)

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Abstract. The chiton *Stenoplax heathiana* Berry, 1946, does not graze randomly but exhibits a high degree of selectivity over the food items ingested. *Plocamium, Gigartina, Polysiphonia, Ulva, Phyllospadix,* and *Rhodymenia* are preferred plant genera. No evidence of "rasping" the substrate for ingestible material was found; instead, this species "nips off" manageable bits of material when foraging.

INTRODUCTION

Stenoplax (*Stenoradsia*) *heathiana* Berry, 1946, is a common polyplacophoran mollusk ranging from Bahía Santo Tomas, Baja California, Mexico, to Ft. Bragg, California (PUTMAN, 1980). It is diurnally restricted to the undersides of mid- to lower-intertidal rocks set in sand/mud substrata, nocturnally emerging to forage onto nearby exposed rock surfaces (HEATH, 1899; personal observations).

Although feeding preferences of several California chitons have been described in the literature (BURNETT *et al.*, 1975, and references therein), no treatment has been given *Stenoplax heathiana.* The only mention made of feeding in this species, to the author's knowledge, comes from HEATH (1899) who suggested that *S. heathiana* merely ingests the flora adjacent to the rocks under which it dwells. The suggestion that this species feeds on drift algae is made by RICKETTS *et al.* (1985) and MORRIS *et al.* (1980), but neither source treats species ingested or preferred. The purposes of this study are to define the diet of *S. heathiana* and to determine if this species feeds selectively or randomly.

MATERIALS AND METHODS

Two sites in California were selected, owing to the availability of chitons: Mission Point, Monterey Co. (35°45′N, 121°56′W) and an area about 1.5 km north of the Pigeon Pt. Lighthouse, San Mateo Co. (37°12′N, 121°24′W). Chitons were observed and collected between 2 March 1981 and 27 April 1981, in early morning or afternoon, depending on the time of minus tides. Both habitats are protected outer coasts with extensive intertidal flats of easily overturned rocks set in sand/mud substrata.

Rocks within these areas were temporarily inverted. When one or more individuals of *Stenoplax heathiana* were located, all species of plants and animals within a 0.5-m radius of the chiton(s) were noted. The chiton(s) were collected, tied down in an expanded position onto a wooden lath, and immediately fixed in 10% formalin (ROBB, 1975). Samples of the noted plants were returned to the laboratory for microscopic examination to provide a reference facilitating the identification of ingested food items. Algae were identified using ABBOTT & HOLLENBERG (1976). Vascular plants and animals were identified by the author.

Gut contents of the collected chitons were examined microscopically following ROBB (1975), except that glycerin was used in mounting gut contents onto slides. Genera and/or species in gut contents were noted. Preliminary dissections revealed no substantial difference between intestine and stomach contents; therefore, the stomach and intestine were considered as a whole. Also, preliminary work revealed no identifiable food items located in the midgut glands; consequently, these were not considered further.

The number of chitons within 0.5 m of an available potential food item was noted, along with the number of chitons found to have ingested that food item. Both data were ranked and a Spearman Rank Correlation (SNEDECOR & COCHRAN, 1980) was performed. Also calculated was the percentage of chitons within the area of an avail-

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